COMMISSION OF THE EUROPEAN COMMUNITIES

environment and quality of life

OCCURRENCE OF NON-PERSISTENT ORGANIC COMPOUNDS IN WATER, SOIL AND FOODSTUFFS: PESTICIDES

1976

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COMMISSION OF THE EUROPEAN COMMUNITIES

Directorate General for Social Affairs—Health Protection Directorate

OCCURRENCE OF NON-PERSISTENT ORGANIC COMPOUNDS IN WATER, SOIL AND FOODSTUFFS: PESTICIDES

REPORT OF A WORKING GROUP OF EXPERTS

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ABSTRACT

The Environmental Action Programme of the Commission of the European Communities requires studies of some of the major pollutants in the environment, in particular the relatively non persistant organic compounds.

Prof. Mestre's report gives a general picture of the levels of certain of these substances in water, soil and footstuffs, and details analyses made between 1968 and early 1973. This data was made available to Prof. Mestres by experts from the nine Member States of the C.E.C.

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PREFACE

Environmental pollution caused by non-persistent organic compounds classed as pesticides is among the questions to receive priority treatment in the environmental programme of the Commission of the European Communities, as presented in the Communities' Official Journal No C112 of 20 December 1973.

The Health Protection Directorate of the Directorate-General for Social Affairs was asked to make an objective assessment of the hazards to man and his environment caused by this type of pollutant. A Working Party of experts from the Member States was thus set up and met in Luxembourg on 19 and 20 March 1973 and on 22 and 23 January 1974, and on 20 and 21 January 1975. A rapporteur, Professor Mestres of the Faculty of Pharmacy of Montpellier (France), was appointed to report on the information available on the contents of non-persistent organic compounds classed as pesticides in water, soil and foodstuffs. The report which follows has been submitted to and approved by the experts who attended the meetings.

ACKNOWLEDGEMENTS

The Commission is very grateful to the members of the Groups of Experts assembled by the Directorate of Health Protection whose suggestions and opinions have made it possible for this report to be written.

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I INTRODUCTION

In the course of the preparation of an environmental action programme for the Commission of the European Communities, the Health Protection Directorate, organized on 19 - 20 March 1973 an exploratory meeting of a Working Group whose objective was to evaluate the risks arising from the various pollutants which may be present in the environment, with particular reference to the relatively non-persistent organic compounds. Pesticides to be included under this general heading are limited to organo-phosphorus compounds, carbamates, dithiocarbamates and herbicides.

Data on the residues of the above mentioned compounds in water, soil and foodstuffs referring to analyses made between 1968 and early 1973 were sent to the rapporteur during 1973 by the experts participating in the meetings.

Insofar as the necessary information has been provided, the data is broken down according to:

1) Nature of the sample analysed
2) country of origin
3) country where the analysis was made
4) date of the analysis
5) reference of the original document relating to the data
6) total number of samples analysed
7) detection limit
8) minimum and maximum amounts found
9) number and percentage of positive results noted
10) average concentrations: general average - median - concentration limit for 90% of the samples (90% of the samples contain less than this concentration) and the average concentration of the positive results alone.

This information fills up ca. 100 sheets that cannot be reproduced here and are summarized in tabular form: (four tables and four diagrams).

Since multidetection methods for pesticide residues allow one to detect and to determine the concentration of several different plant-protection products on the basis of a single analysis, and since it is possible to analyse one sample by several different methods, it is difficult to define the exact number of samples examined when dealing with data presented in various ways.

The number of determinations noted in this report is of the order of 26,000.

As in the case of research into persistent organochlorine pesticide residues*, the findings for non-persistent pesticide residues reveal great differences between batches analysed, in which the number of samples per batch may range from one to several hundreds.

The representativity of a large number of analysed samples may also differ.

A large number of samples may result from series of analyses on the same product: flour, cereals, lettuces, apples, and so on, for example, or from the inclusion of various unspecified foodstuffs analysed over a period of varying length. Data for this last group is equivalent to that which would be obtained by adding the detailed results of several sets of analyses of small numbers of samples of foodstuffs, but as the individual nature of these various foodstuffs is not known this data cannot be set in any group such as fruits, vegetables, meat and so on.

Although for some of the data received information lacked on sampling programs and objectives, all the received figures have been included in this survey without discrimination.

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* "the content of organohalogen compounds detected between 1968 and 1972 in water, air and foodstuffs and the methods of analysis used in the nine Member States of the European Community" by R. Mestres.

Data relating to agronomical studies has been omitted. Results included refer only to samples corresponding to survey samples taken on the wholesale or retail market or from producers whose crops are being harvested for marketing.

The results from the various official laboratories of the Member States of the Community indicate a certain level of pollution. However the interpretation of this information must be handled with care due to the bulk of analyses to be made to get a perfect analytical survey of such a large, moving and changing field of investigations on non-persistent pesticide residues in food and the environment.

Because of the lack of complete information, this document will merely state the results found after referring to the methods of analysis and sampling from which they were derived.

II METHODS OF ANALYSIS

Due to greater variability in type, structure and properties, the methods of analysis for non-persistent pesticides are less uniform than those for persistent organochlorine pesticide residues, and include gas chromatography, thin-layer chromatography, ultra-violet and visible spectrophotometry colorimetry, and also, biological methods.

The compounds dealth with in this study are primarily the organophosphorus pesticides, the carbamates and the dithiocarbamates.

Most organophosphorus compounds lend themselves readily to gas chromatography and are normally specifically detected either by the use of the alkali flame ionisation detector (AFID), of the flame photometry detectors (FPD).

These two types of detectors have been frequently used (Belgium - Denmark - Germany - France - Italy - Great Britain), though the electron capture detector was also used to provide some results (Germany).

The inhibition of enzymes by organophosphorus compounds has also been used for their general and specific detection following separation by thin-layer chromatography (France - Italy - Netherlands).

The detection of parathion and its homologues was carried out by the AVERILL and NORRIS colorimetric method. This procedure incorporates isopropyl alcohol and benzene extraction and subsequent purification of the extract by adsorption chromatography (Italy).

Dimethoate was determined following extraction by acetone and chloroform and purification on an alumine column, by colorimetric measurement of the organic phosphorus (Italy).

Malathion was also measured by colorimetry of the copper complex with dimethyl dithiophosphoric acid after extraction with carbon tetrachloride (Italy).

Carbaryl, whose gas chromatography identification is difficult, has been identified after extraction with methylene chloride, by coupling with 1-nitro-4-amino-benzene sulphonic acid and colorimetric measurement (Italy).

Colorimetric methods are also still used for measuring residues of dithiocarbamates following liberation of the carbon sulphide by acid hydrolysis (Belgium - Germany - France - Netherlands).

Benomyl residues were measured by ultra-violet spectrophotometry after extraction with ethyl acetate and clean up of the extract by acid extraction and subsequent partition into an organic phase after making the solution basic (Belgium - France).

The analytical results are divided into studies carried out in natural water and those dealing with foodstuffs.

III RESULTS OF THE ENQUIRY

III - 1 - Results dealing with non-persistent pesticide residues in natural water

Except for carbaryl, all the non-persistent pesticides referred to are organophosphorus compounds, so no distinction will be made between the residues which will simply be listed in alphabetical order.

However, their geographical distribution will be taken into account because of considerable differences between the water courses examined, both in their nature : industrial or agricultural environment, and in their size.

These results, represented in table A1 and table A2, refer to the rivers of continental Italy, of Sicily an Sardinia, the Rhine examined in the Federal Republic of Germany and in the Netherlands, and irrigation and drainage canals and ponds in an agricultural area of the Rhone delta.

Fifteen non-persistent pesticidal compounds in all are mentionned, with positive concentrations varying from a few tenths of a nanogram per litre (10^{-13} w/vol) to about twenty micrograms per litre (10^{-8} w/vol). Only parathion was found in all the samples examined.

In the waters of the Rhine, nine organophosphorus pesticides and carbaryl were identified and measured. The highest concentrations found, in decreasing order (in mg/m^3) were:

dimethoate (2.40) - disyston (2.0) - sulfotep (1.95) - carbaryl (1.2) - parathion (1.0) - formothion (0.9) - diazinon (0.38) - fenitrothion (0.2) - malathion (0.017) - and parathion methyl (0.016).

The variation of concentrations of these residues found in the Rhine in the Netherlands from January to August 1972 is apparent from the results of a set of 34 samples taken during this period.

Dimethoate, diazinon and parathion were found in each analysis, and their average respective concentrations at that time were equal to:

0.73, 0.08 and 0.027 mg per m^3

In 41% of the cases malathion was detected with the average amount corresponding in general to : 0.0028 mg per m^3.

Analyses of water in other German rivers did not usually give positive results, except for particular cases arising from local pollution by disyston and sulfotep in the Wupper.

In an important series of analyses of surface water in Germany (213 samples), in less that 2% of them only parathion was found.

The results shown for surface water in the Camargue, in France, refer to water in irrigation and drainage canals in ricefields, vineyards and orchards and to neighbouring ponds. Analyses of 64 continuous samplings spread over the 1971 agricultural season revealed (in one case out of the 64) the presence of traces of azinphos methyl, of ethion and methyl parathion, two cases of fenitrothion residues, but on 26 occasions (42% of cases) residues of parathion, which is more widely used.

These waters differ from those of the Rhine, in their much weaker flow and by the close proximity of ricefields which drain into them.

An examination lasting a year (1969) of the waters of ten rivers and two lakes in the continental part of Italy and its islands revealed traces of residues of nine organophosphorus pesticides in the following proportion of cases (out of 45 samples, with each sample corresponding to an average reading representing a period of three months):

methyl parathion (73%) - fenchlorfos (40%) - parathion (28%) malathion (20%) - chlorpyriphos (13%) - diazinon (11%) carbophenothion (4.4%) - ethion and dimethoate (2.2% i.e., 1 case only).

The highest average amounts found over a three-month period, (in mg/m^3) in decreasing order, were:

dimethoate (1.59) - diazinon (1.295) - malathion (0.703) methyl parathion (0.491) - parathion (0.261) - fenchlorfos (0.075) chlorpyrifos (0.048) - ethion (0.0259) - carbophenothion (0.0094), and, allowing for the occurrence frequencies quoted above, this shows that the amounts found in rivers in 1969 were virtually always below 1 mg/m^3.

This conclusion can be applied to all the figures given for the pollution of surface waters by the residues of organophosphorus pesticides: the frequencies vary from low to high depending on the pesticides, and the amounts usually fall between the detection limit (about 0.0004 mg/m^3) and 1 mg/m^3.

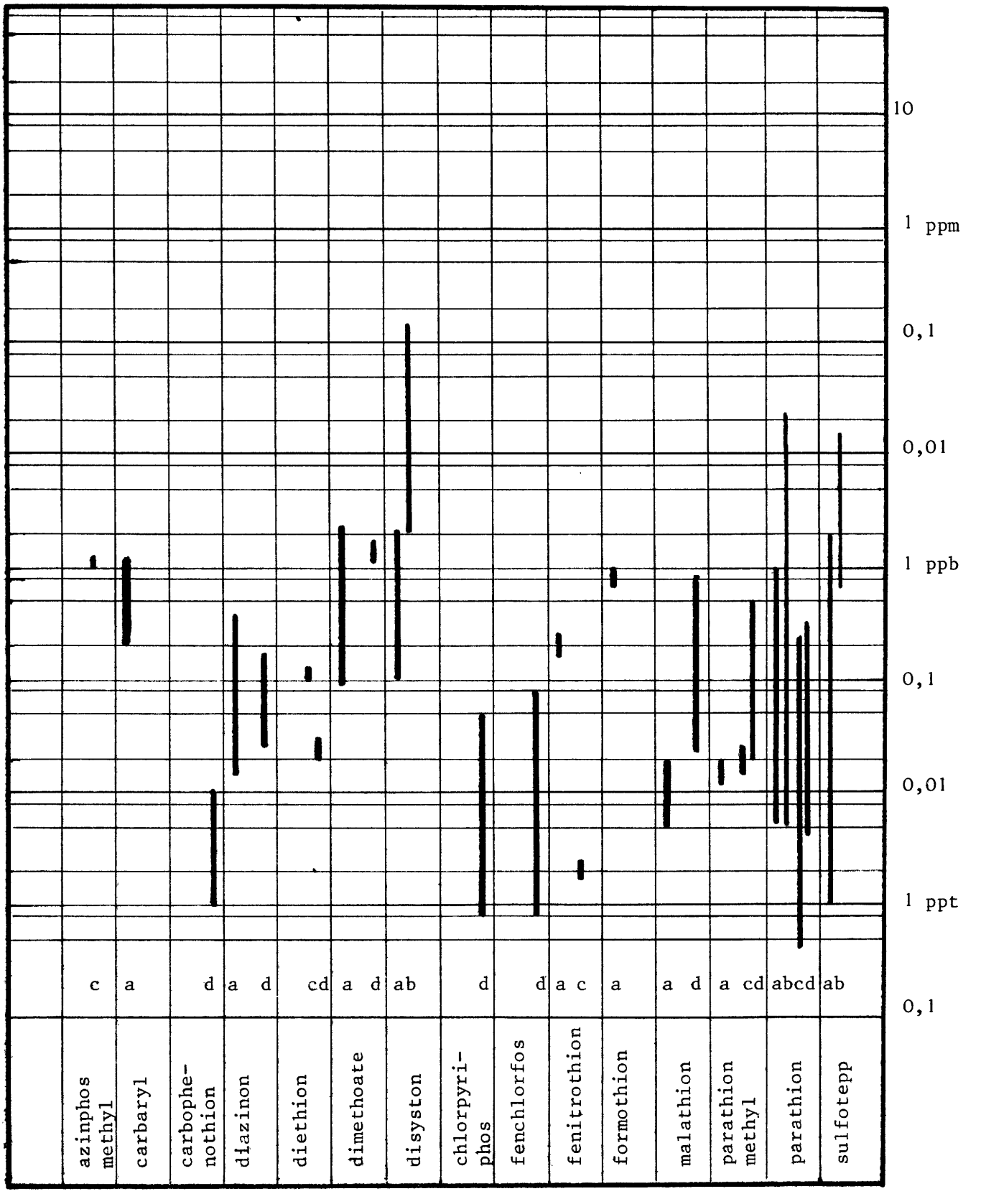
Table A.1

Summary of data on non persistent pesticide residues in river waters (ppb - mg/m^3 - 10^{-9})

PESTICIDE	a) FRG - NL Rhine		b) FRG Rivers		c) FRANCE Camargue		d) ITALY Rivers	
	n	range	n	range	n	range	n	range
Azinphos methyl	34	n.d			62	1.2		
Carbaryl	36	.2(*) - 1.2						
Carbophenothion							45	.001 - .009
Diazinon	36	.014- .38					45	.025 - .179
Diethion					62	.1	45	.025
Dimethoate	36	.085 - 2.40					45	1.59
Disyston	25	.1 - 2.0	14	2.0 - 113				
Chlorpyriphos							45	.0008 - .048
Fenchlorfos							45	.0008 - .075
Fenitrothion	34	.2			62	.002		
Formothion	34	.9						
Malathion	36	.005 - .017					45	.025 - .703
Methyl parathion	34	.016			62	.02	45	.020 - .491
Parathion	241	.006 - 1.0	247	.005- 23.5	62	.0004 - .21 / 23	45	.004 - .261
Sulfo Tepp	25	0 -1.95	40	.66 - 18.8				
General ranges		.005 -2.40		.005-113		.0004 - 23		.0008-1.59

(*) . 2 = 0.2

WATERS - Summary of data



a = Rhine (FRG and NL)
b = other rivers of FRG
c = France Camargue (agricultural zone)
d = Italy (4 rivers and lakes)

III - 2 - Results dealing with non-persistent pesticide residues in foodstuffs

III - 2 - 1 - Organophosphorus compounds

Theoretically, the median values, the maximum values for 90% of the samples, the general values and the mean of the positive results should provide sufficient information for evaluating the level of pollution in each foodstuff with respect to its residues, and this should enable us to assess the average content in the total unprepared food. Such an assessment is not possible with the present results since the sampling methods were not standardized for producing an overall study of pollution.

In analysing for residues, it was inevitable, that priority should be given to the study of agricultural produce which had been treated, to detect locally used pesticides in that produce.

Conservely, in some few cases it might occur that the examination of products, stated to be untreated with a view to discovering possible irregularities and imposing restrictions, may have led to samples being selected which were free of pesticide residues.

As a result of this, although the residues observed and the percentage of positive results are of great interest in each of the particular cases studied, they cannot be extrapolated to all commercial agricultural produce of the same kind in Europe and even less to all foodstuffs of vegetable origin.

Each set of results provided information which can only be discussed, interpreted or summarized in its own particular context. So many points of detail cannot be enlarged upon here, all the more so since the particular contexts are not precisely defined.

Tables B1 and B1(a) show that residues of twenty organophosphorus pesticides were measured in fruit and in vegetables, whereas only four were mentioned in the case of cereals.

The number of samples with which positive results of a residue of pesticides were noted varies from 1 to 48%, with a median value of 9% for fruit and 10% for vegetables.

It appears, moreover, that in the 8,783 cases mentioned where organophosphorus pesticidal residues were found in samples of fruit and vegetables, the vast majority of the positive amounts registered were below 1 mg/kg: the only four "exceptionaly" high results were 4.4 mg/kg for malathion, 4.5 mg/kg for dimethoate, 2.9 mg/kg for phosalone and 20 mg/kg for parathion.

The nine organophosphorus pesticide residues noted, both in fruit and vegetables, are in alphabetical order:

bromophos - carbophenothion - diethion - dimethoate - malathion - methyl parathion - mevinphos - parathion and phosalone.

In fruits the following residues were also found:

ethyl azinphos - methyl azinphos - fenitrothion and meta isosystox.

In vegetables, as well as the nine first mentioned, residues of demeton methyl sulfoxide, diazinon, disulfoton, fenchlorfos, fonofos and trichloranate were found.

In cereals and flours: malathion, and authorised product, is virtually the only organophosphorus pesticide residue to be found (table B 1(a)). Its concentrations, averages about 0.01 mg/kg, while 3.0 mg/kg are accepted as residues in cereals and vegetables (except root vegetables) and 0.5 mg/kg in root vegetables and fruits by some Member States of the European Community.

Tables B 2 and B 3 give another representation of the result obtained.

Table B.1 - Summary of data on residues of non persistent pesticides : organophosphorus compounds

PESTICIDE	1 B	2 D E N	3 R F G	4 F	5 N L	6 E I R E	7 I	8 L	9 U K	FRUITS n. samples	FRUITS range mg/kg min.	FRUITS range mg/kg max.	FRUITS % positive	VEGETABLES n. samples	VEGETABLES range mg/kg min.	VEGETABLES range mg/kg max.	VEGETABLES % positive
Azinphos Ethyl				I						178	0.01	0.37	7.3				
Azinphos Methyl		I		I						203	0.01	2.4	15.3				
Bromophos		I	I							149		0.38	1.3	140	0.006	0.12	10.7
Carbophenothion			I	I						88	0.01	0.03	3.4	55		0.04	1.8
Demeton methyl sulfoxide			I						I					54		0.2	1.8
Diazinon		I	I	I	I				I					48 1327	<0.02 0.05	0.12	48 3.3
Diethion		I	I	I					I	420	0.001	2.0	8.9	3		0.08	33
Dimethoate		I	I	I			I		I	401	0.01	4.5	9.4	129	0.02	0.06	13.9
Disulfoton SO-SO_2			I											33		0.04	3
Fenchlorfos									I							0.09	
Fenitrothion				I					I	185	0.02	0.26	5.4				
Fonofos				I										38	0.01	0.69	13.1
Malathion			I	I	I		I		I	209	0.001	0.8	18.1	343	0.01	4.4	1.1
Meta isosystox	I									25		0.02	20				
Mevinphos	I	I								86	0.06	0.50	13.9	80	0.01	0.16	23
Parathion	I	I	I	I	I		I		I	585	0.001	20	17.4	1.560	0.005	4.2	27.6
Parathion methyl + parathion							I			960	0.01	0.50	37.7	953	0.01	0.26	23
Parathion methyl				I			I			195	0.001	0.18	13.9				
Phosalone				I						158	0.01	2.9	32.2	9		0.40	11
Trichloronate		I		I										169	0.005	0.10	48
Total	3	8	9	13	3		5		8	3.842				4.941			

Table B.1 a - Summary of data on residues of non persistent pesticides : organophosphorus compounds

PESTICIDE	1 B	2 DEN	3 FRG	4 F	5 NL	6 EIRE	7 I	8 L	9 UK	CEREALS n. samples	CEREALS range ppm (mg/kg) min.	CEREALS range ppm (mg/kg) max.	CEREALS % positive	FOOD n. samples	FOOD range ppm (mg/kg) min.	FOOD range ppm (mg/kg) max.	FOOD % positive
Bromophos			I											742	0.003	0.12	0.26
Dichlorvos			I							125		0.2					
Malathion			I II	I	I		I		I	717 909	0 0.002	12.7 1.14	 11.8	 2747	 0.004	 1.04	 4.3
Parathion			I							704			0	3073	0.003	0.60	5.5
Total			5	1	1		1		1	2455				6562			

Table B.2

FRUITS - Summary of data - Organophosphorus compounds

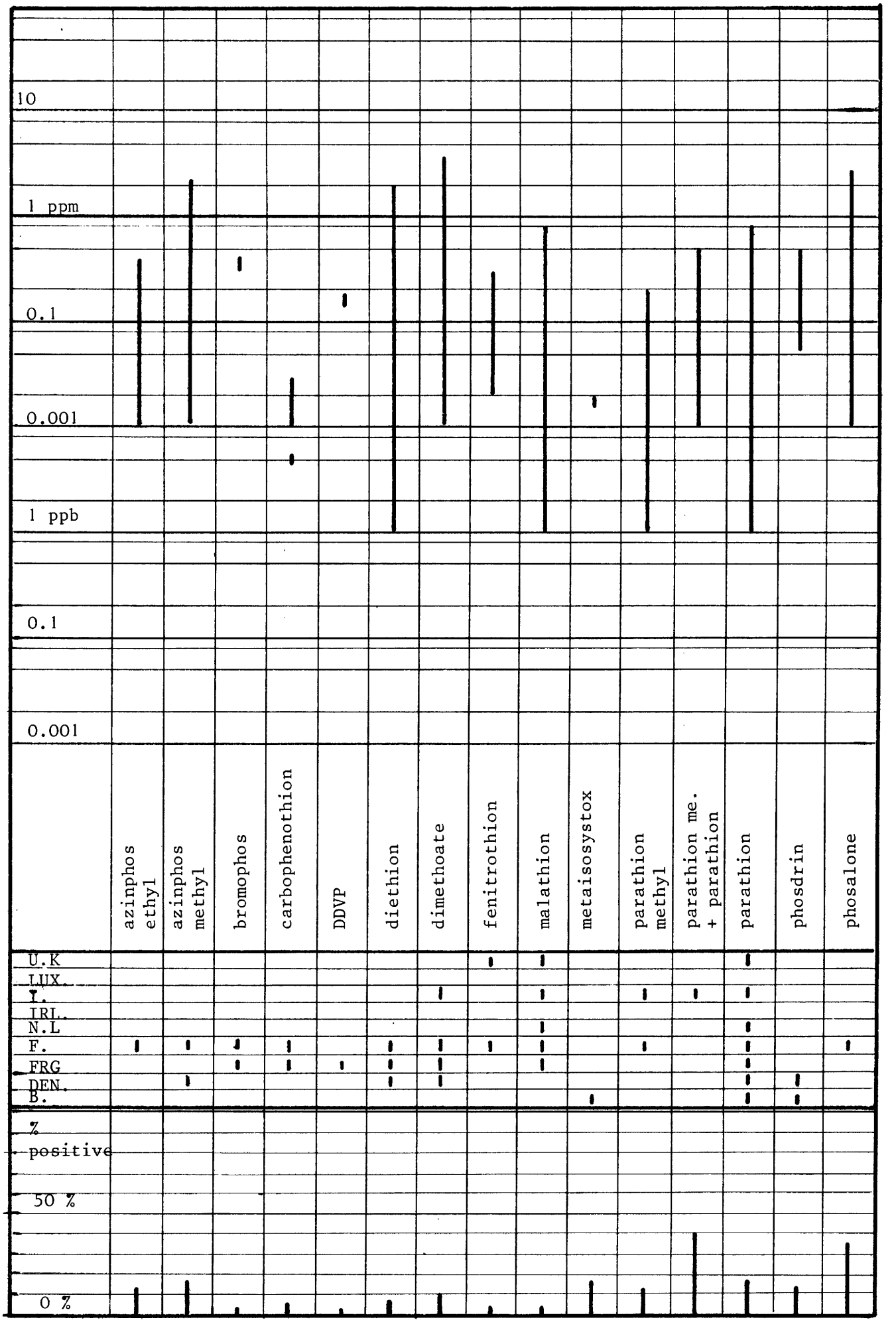
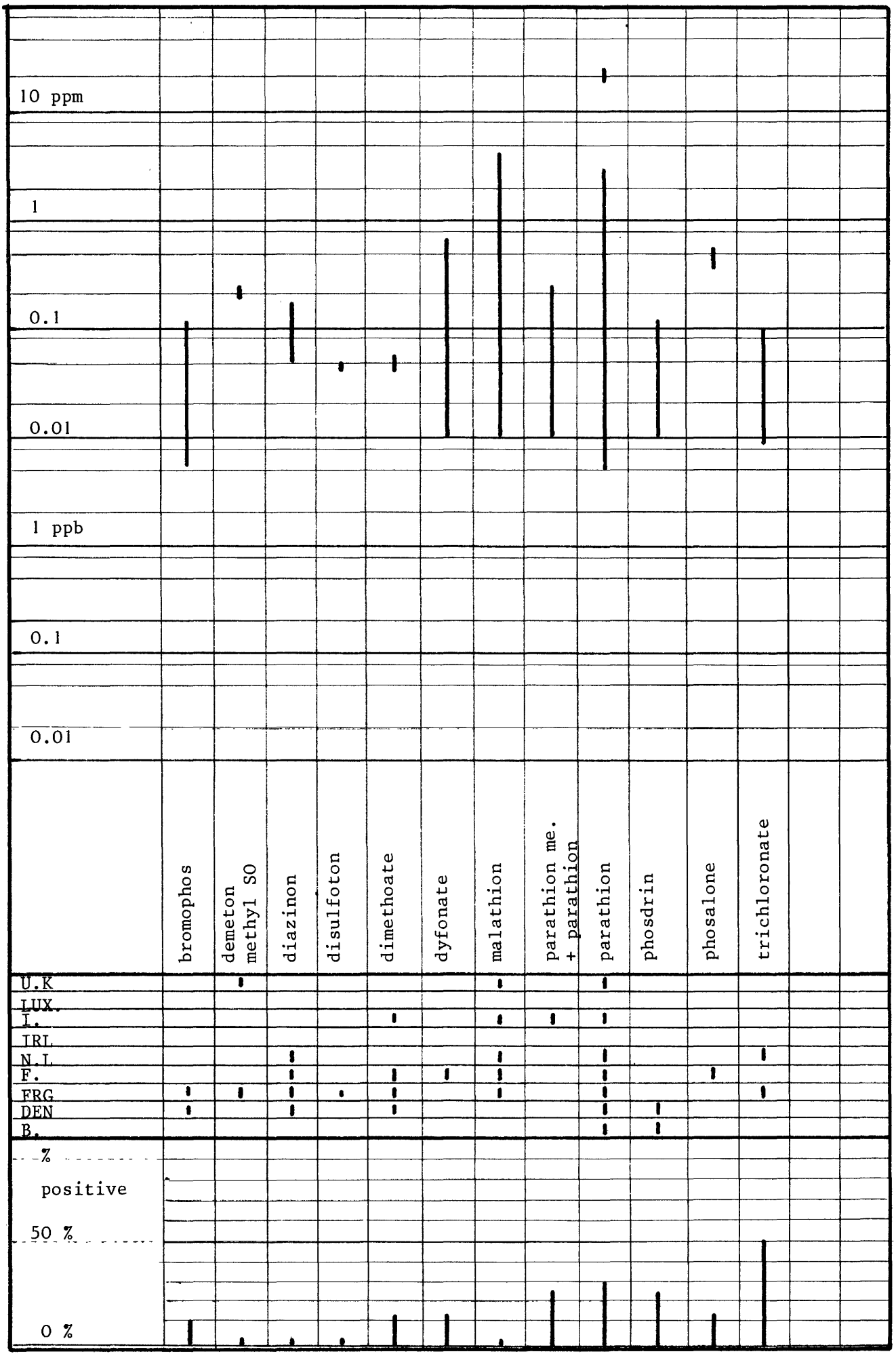


Table B.3

VEGETABLES - Summary of data - Organophosphorus compounds



III - 2 - 2 - Non-organophosphorus compounds

The different delegations sent informations about 18 relatively non-persisent non-organophosphorus compounds.

Ten consist in pesticides without any chlorine in their molecules : aldicarb - benomyl - biphenyl - carbaryl - dithiocarbamates - o-phenyl phenol - propham - sulphur - thiabendazole and thiophanates and eight other organochlorine compounds with nitrogen or sulfur or both of these heteroatoms:

Captan - chlorpropham, dichlofluanid, dichloran, endosulfan, folpet, quintozene and tecnazene.

Since this last group regarded as being non-persistent, was not, or is only briefly, considered in the report of the Working Party on the residues of persistent organochlorine compounds.*

A total number of 14 pesticides were dealt with in the case of fruits as well as in the case of vegetables (the dithiocarbamates group being counted as a single product).

Results for 9.354 determinations, are listed i.e. 3.165 for fruits and 6.189 for vegetables.

The percentages of positive cases and the amounts detected are generally much higher here than the results of organophosphorus pesticidal residues.

This is to be expected, since pesticides in this group are more specific in nature and it consequently was possible to conduct more effective tests. This confirms the need for a standard procedure to be imposed on these tests, as suggested above (III - 2 - 1).

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* The content of organohalogen compounds detected between 1968 and 1972 in water, air and foodstuffs and the methods of analysis used in the nine Member States of the European Community by R. Mestres.

Problems on these compounds are quite different from those of the organophosphorus pesticides and no common measure exists between these various products.

The data recieved on aldicarb, an extremely toxic compound, is far from complete.

Those on carbaryl, with 100% positive results in one only set of 46 samples are questionable on what would have been found if more analysis had been performed.

For dithiocarbamates, detailed data given for 241 samples of fruits and 953 of vegetables show that dithiocarbamate residues were found in 13.2% of the fruits and 17.6% of the vegetables analysed.

In about 487 samples of unclassified foodstuffs, it appears that 7.1% contained dithiocarbamate residues.

Proportion of residue-containing samples in 195 fruits and 244 vegetables analysed elsewhere were not given, but the minimum and maximum limits are there about the same.

Thiram, which was subjected to a special study, was found in 11.1% of the 63 samples of fruits and in 7.7% of the samples of vegetables tested.

It should be pointed out at this stage that the percentage of positive determinations in analyses is low resulting from an examination strongly biased in a particular decision.

Concentrations observed in fruits are always below the tolerance limits, those in vegetables vary considerably and include cases where the tolerated amount of 3 mg per kg is clearly exceeded.

Thiophanate residues, difficult to analyse before 1973, were subjected to only a small number of examinations, which had to be strongly biased, and their results cannot be considered from a general point of view.

The same is true of sulphur residues, which are neglected by most of the laboratories.

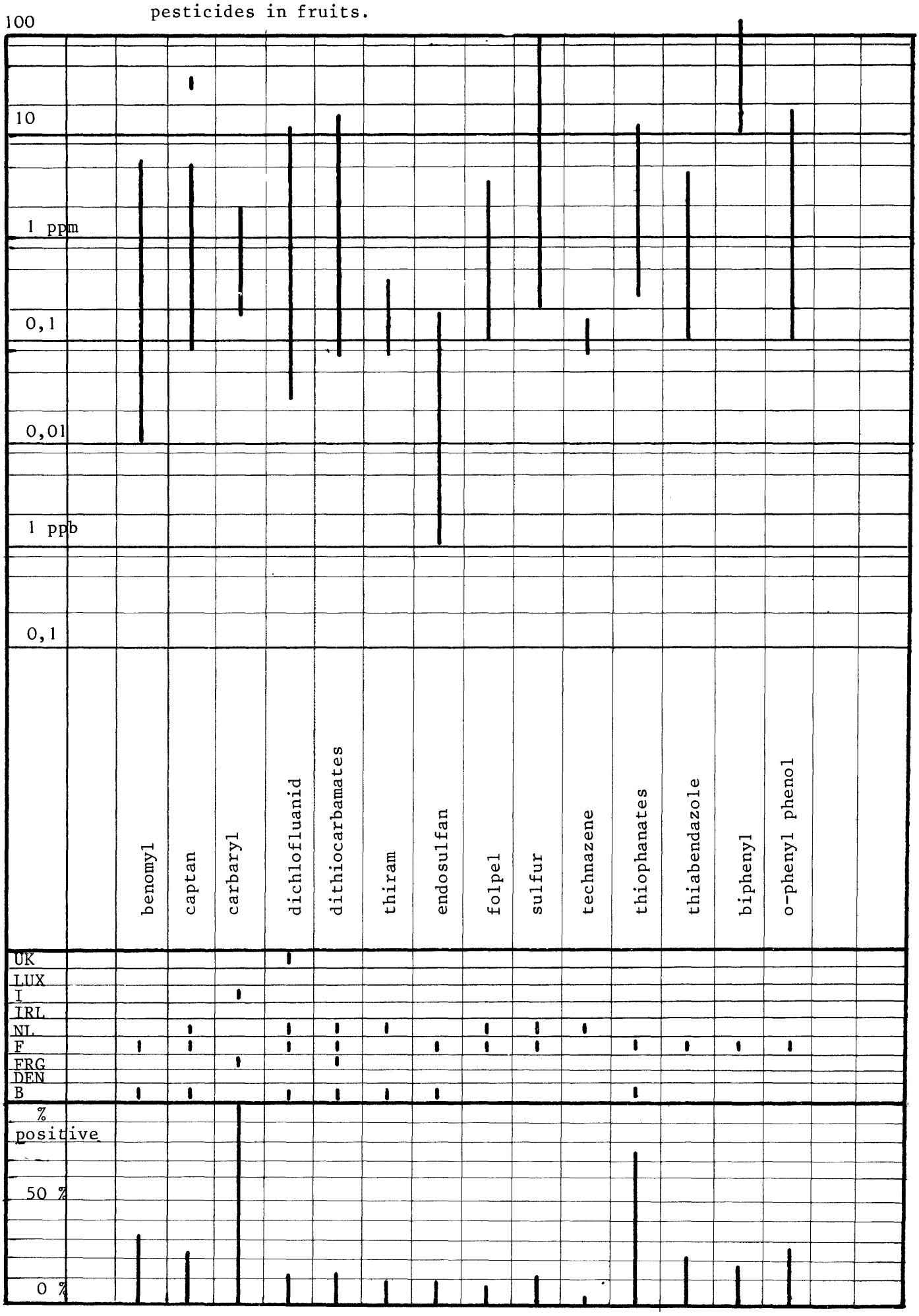
The other pesticide residues of this group: non-persistent organochlorines, substances used both before and after harvesting and fungicides used after harvesting, do not come within the terms of reference drawn up by the Working Party at its meeting on March 19 and 20, 1973. Details will therefore be limited to the tables of data received, summarised on tables C 1, C 2 and C 3.

It should however, be pointed out that an important set of potato samples showed a high frequency of propham residues, The lack of sufficient data about propham and chlorpropham residues should however, be emphasised; these grow inhibitors being only temporarily used on a part of the harvested potatoes.

Table C. 1 - Summary of data on residues of non persistent pesticides in fruits and vegetables (other than the organophosphorus)

PESTICIDE	1 BEN	2 DEN	3 FRG	4 FRG	5 NL	6 EIRE	7 IL	8 IL	9 UK	FRUITS n. samples	FRUITS range ppm min.	FRUITS range ppm max.	FRUITS % positive	VEGETABLES n. samples	VEGETABLES range ppm min.	VEGETABLES range ppm max.	VEGETABLES % positive
Aldicarb			I												0	0.2	
Benomyl	I			I						217	0.01	6.15	33.6	22	0.07	0.30	9.0
Captan	I			I	I					718	0.08	5/40	24.5	412	0.2	5	0.7
Carbaryl							I			46	0.15	1.75	100		1.0	2.0	
Chlorpropham			I	I										14 311	0.27 0.004	1.02 7.5	100 26.3
Dichlofluanid	I			I	I				I	572	0.03	11.8	16.6				
Dichloran	I													117	0.02	0.17	47
Dithiocarmates	I		I	I	I					241 195	0.0 0.0	13.9 5.8	12.2	953 487 244	0.05 0.8 0.0	66 42.5 65	17.6 7.1
Thiram (only)	I				I					63	0.07	0.39	11	439	0.07	48	7.7
Endosulfan	I			I						306	0.002	0.15	8.5	579	0.08	10.	23.6
Folpel				I	I					40	0.1	3.	5.				
Prophame				I	I									400	0.005	2.65	69.8
Quintozen	I	I		I	I				I					1390	0.006	12	37.8
Sulfur				I	I					138	0.2	84.	10.	76	0.11	30	6.5
Technazen	I				I				I	47		<Tol.	2.1	145	0.004	1.2	14.2
Thiophanate	I			I						69	0.25	11.8	74.	4	0.11	22.4	100
Thiabendazole				I						284	0.1	7.2	22.5				
Biphenyl				I						117	10	136.	14.5				
O-phenyl phenol				I	I					112	0.1	19	27.7				
Total number	10	1	4	14	10		1		3	3.165				6.193			

Table C 2 - Summary of data on residues of non persistent, non organophosphorus pesticides in fruits.



able C 3 - Summary of data on residues of non persistent, non organophosphorus compounds in vegetables.
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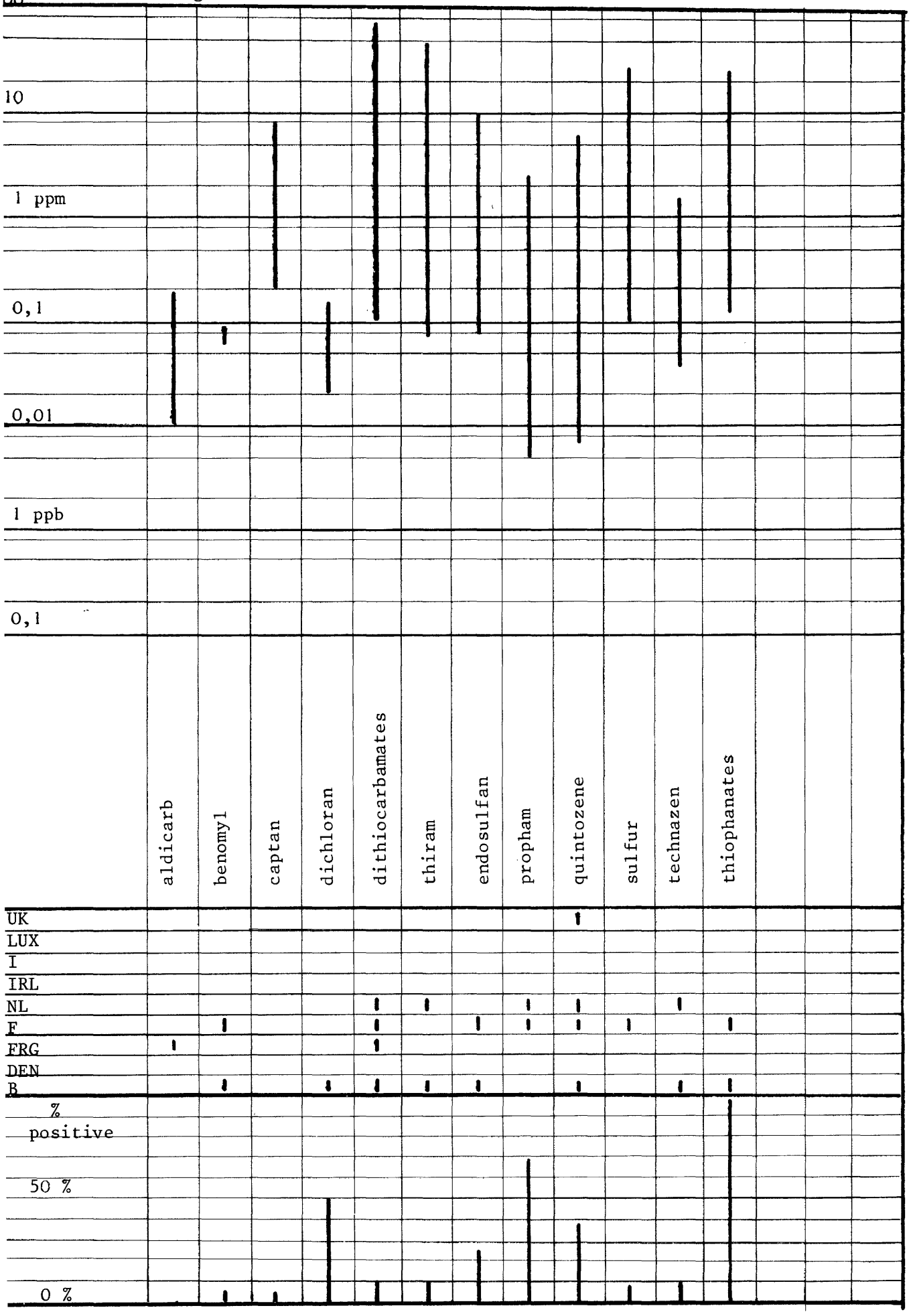

IV GENERAL CONCLUSIONS

The official laboratories of the member countries of the Community have looked for environmental residues of pesticides from plant-protection products other than the classical organochlorines. The list of about 26,000 determinations, which presumably represents only a part of the existing data, bears withness to this activity.

The names of 22 organophosphorus pesticides and of 18 various non-organophosphorus products appear in this report.

In order to establish the presence and amount of a residue, colorimetric and spectrophotometric methods, as well as gas liquid chromatography using specific detectors have been employed. These methods ensure much tighter control of the qualitative analysis of organophosphorus compounds than was possible for the electron capture detector in the analysis of organochlorine compounds.

Surveys into the pollution of watercourses and surface waters revealed traces of fourteen organophosphorus pesticides and one carbamate.

These investigations deal with waters of very different types: a large international river like the Rhine, other rivers of lesser flow and length in Germany and Italy and drainage canals in agricultural areas in France.

The diverse origins of pollutants present in a river like the Rhine ensure that the presence of pesticide residues is much more regular, but the amounts noted are of the same order as those in other surface waters, i.e., between 0.01 and 1 mg per m^3, with rare exceptions where the maximum amounts reached 2 mg per m^3.

Near agricultural areas which have been specially treated, especially ricefields, drainage canals can, at the time of treatment, contain distinctly higher concentrations, but since their flow is negligible in comparison with the large rivers, the quantitative effect of these canal waters on environmental pollution is reduced.

Practically the only foodstuffs mentioned were those of vegetable origin. The residues of non-persistent pesticides are, in fact, metabolised after ingestion by animals and are generally not found in meats and fats, which explains the very small number of tests relating to them. On the other hand, more than 17,000 determinations from samples of fruits, vegetables, cereals and unspecified foodstuffs, listed under the heading "food", revealed the presence of residues of thirteen different organophosphorus pesticides in fruits and in vegetables; malathion was however the only non-persistent pesticide residue found in cereals.

Although tests were directed at the produce most likely to contain treatment residues, the average frequency of positive determinations is approximately ten per cent and the amounts noted are almost always lower or much lower than one mg per kg.

Malathion residues, in particular, were found in cereal grains and in flours in concentrations much lower than those legally allowed by the projected Directive of the Commission of the European Community.

Of the 18 relatively non-persistent non-organophosphorus organic compounds - noted in the reports of the official laboratories - the main pesticides mentioned which are of interest to this investigation are the various dithiocarbamates. Their residues were found in seven to sixteen per cent of the samples analysed, in many cases in concentrations which largely exceeded the admissible levels accepted in several States of the Community. This is an agronomical problem which is at present being closely studied by the test laboratories and the agronomical services, so it should not be long before the excess amounts noted will quickly decrease.

Results for the 43 non-persistent pesticides listed in this survey show the spread caused by the high number of plant-protection products used, which may be beneficial for the consumer, reducing the risks of repetitive agression by a single compound.

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